SUMMARY

The objective of this study was to gather some basic information which would be of use in formulating a rational programme for the improvement of yield and protein content in Bengal gram (Cicer arietinum L.). The results obtained may be briefly summarised as follows:

1. Sixty-four genotypes, having their origin in the important gram growing regions of the country (as well as some of exotic origin) were grown in four environments, i.e., two seasons at Delhi and two at Pune, Bihar. Combined analysis of the data collected over the four environments showed that the variance due to genotypes was highly significant as was also that due to genotype x environment interaction. Partitioning of these variances into their components showed that the genotype x environmental component was larger or as large as the genotypic component.

2. In view of the existence of appreciable genotype x environment interaction, it was considered desirable to evaluate the pheno-
typic stability of each of the 64 genotypes over the four environments. For this purpose, the techniques developed by Finlay and Wilkinson (1963) and Eberhart and Russel (1966) were utilized. In regard to grain yield, a positive association between mean yield and regression on the environmental index was noted; however, quite a few high yielding varieties were of average stability as shown by unit regression and low deviation. In respect of protein content, on the other
hand, there were no genetically conditioned differences in respect of the regression, the V x E (linear) term being non-significant.

Among the yield components studied, number of branches behaved more or less like yield, a number of high-branching varieties having regression coefficients around unity. In the case of pods per plant, there was a distinct inverse association between performance and stability while no clear trend was noticeable in respect of grains per pod and 100-grain weight.

The possibility of a cause-effect relationship between previous selection history and phenotypic stability has been pointed out. A consideration of the varieties with average stability (h = 1) suggested that there may be no association between plant type and stability in this crop.

3. The interrelationship between yield and its components, intern to between the components and between protein content, on the one hand, and yield and yield components, on the other, were studied using correlation and path analysis at the phenotypic, genotypic and environmental levels.

At the genotypic level, yield was positively correlated with its components except 100-grain weight, the same trend being shown in all the four environments. The yield components also showed a positive intern to association with the exception of 100-grain weight which showed a negative association with the other three components. Protein content was not significantly correlated with grain yield though there is a trend towards negative association. A similar picture was revealed when the relationship between protein content and yield
components was studied; the negative association being particularly marked in the case of grains per pod. An exception was the association between grain weight and protein content which was positive and of appreciable magnitude.

Path analysis at the genotypic level showed that pods per plant made the maximum direct contribution followed by 100-grain weight. The direct effects of number of branches and grains per pod were much lower. Consideration of the indirect effects highlighted the importance of number of pods, the indirect effect via this character playing an important role. The indirect effect via seed weight was consistently negative so that the appreciable direct effect of seed weight was masked, when its correlation with yield was considered.

The residual path made an appreciable direct contribution. This suggests the need for including other characters, such as number of secondary branches, photosynthetic or nutrient uptake efficiency in the path analysis. Since such characters are likely to be correlated with the components already considered, their inclusion may well result in a different picture than the one presented in this study.

4. The genetic architecture of yield as well as its components and protein content has been analysed using a diallel cross involving seven improved strains, released by different grain-growing States. The diallel data were subjected to combining ability analysis as well as analysis of gene effects using the graphical and statistical approaches. The fixed effects model was used in both the analyses, the experimental population being considered to be the entire population about which inferences were to be made.
Among the five yield components studied, number of branches and grains per pod showed a predominance of additive gene effects. The graphic analysis suggested the presence of epistatic disturbances but this was not seen in the combining ability analysis. A somewhat similar though reverse situation was met with in respect of pods per plant and days to flower where the s.o.a. effects were significant but the Vr Wr graph had unit slope. In respect of 100-grain weight both combining ability and gene effect analysis revealed the existence of epistatic effects.

Surprisingly, in respect of grain yield the s.o.a. effects were non-significant while the regression of Wr or Vr did not differ from unity. Both graphical as well as statistical analysis of gene effects showed some dominance effects in the partial dominance range. There is no clear explanation of the anomaly of yield being free from epistatic effects while its components show evidence of non-additive effects.

In respect of protein content all three approached indicated substantial additive effects but they differed in regard to the importance of the non-additive component. While the graphic analysis suggested the absence of epistatic disturbances, s.o.a. effects are substantial. The existence of marked overdominance was revealed both by the graphical analysis and by the ratio of $(H/D)^{1/2}$. In this connection it has been pointed out that wherever overdominance has been reported, adequate analysis revealed the existence of epistatic effects also, biasing of estimates due to linkage effects has also to be kept in mind where pure lines have been used.
3. The implications of these results for the choice of breeding methodology and in particular the potentialities for exploitation of heterosis in bengal gram have been discussed.